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Araştırma Makalesi Research Article

Proposed Rules of Parentheses ( ) and Asymmetrical Hill Slopes

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Abstract

Landslide is one of the natural disasters where land is rugged and in deep excavations. Topographic maps with a scale greater than 1/25,000 could give definite idea about the attitude of significant discontinuities and boundary of landslides. The proposed parenthesis rule is important to locate and orientate linear engineering structures including motorway, highway, railway and pipeline. Most of the slope instability problems in stratified rocks are controlled by the outsloping major discontinuities. The main discontinuity types are bedding and layering planes. They control the stability in civil engineering projects. The proposed rules enhance investigator and designer considerably in terms of safety–security, environment, timing and cost.

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1. INTRODUCTION

The landslides are generally turns into rotational landslides (Figures 1 - 2). A rotational land slide could be identified easily on topographic maps with a greater than 1/25,000 scale (Figure 3). The authors suggested the name “parenthesis ( ) rule” to describe two concave contour sets each other (Leventeli et al., 2019). The proposed parenthesis approach could enhance any person to identify the presence of a slide with accuracy over 99% on a topographic map. The following properties depicted in Figure 3 which is modified from Leventeli et al. (2019) could be easily revealed:

(1) The contours 1330 – 1450 are concave southwards whereas 1275 – 1330 are concave northwards.

(2) The stream has been shifted about 500 m towards south.

(3) As described in Yilmazer et al. (1997a) the trinity water, discontinuity, and clay, abbreviated as WDC, are main causatives of all geotechnical problems. Limestone is highly pervious and erosion resistive creating higher topography which in turn gets higher precipitation and infiltration. However, the serpentinite as hanging wall and imbricated thrust faults in serpentinite are impervious. Serpentinite confines limestone which is footwall. Hence an artesian aquifer in limestone formed. The piezometer level daylights at the main tectonic contact yield numerous seepages and springs (W) keeping the hanging wall wet.

(4) The main reverse fault between limestone and serpentinite and intertwined thrust faults also in serpentinite are the major discontinuities (D).

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(5) Faults and bedding planes in any kind of rocks, excluding the crystalline limestone, bear clay minerals (C). About one-millimeter-thick clay seam may cause huge landslide if the discontinuity dips outslope (Figure 4).

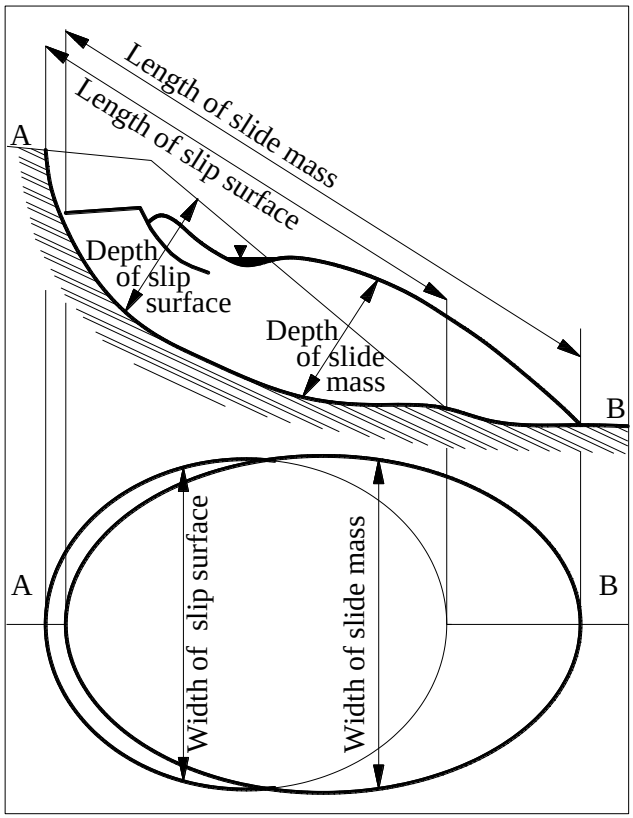

Figure 1. *Principle Components of a Typical Rotational Landslide*

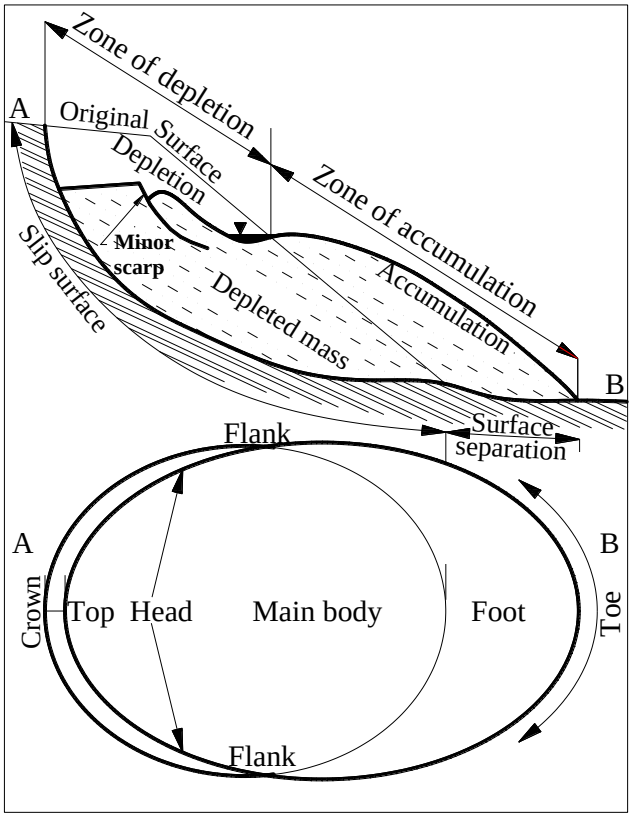

Figure 2. *Major Dimensions of a Typical Rotational Landslide*

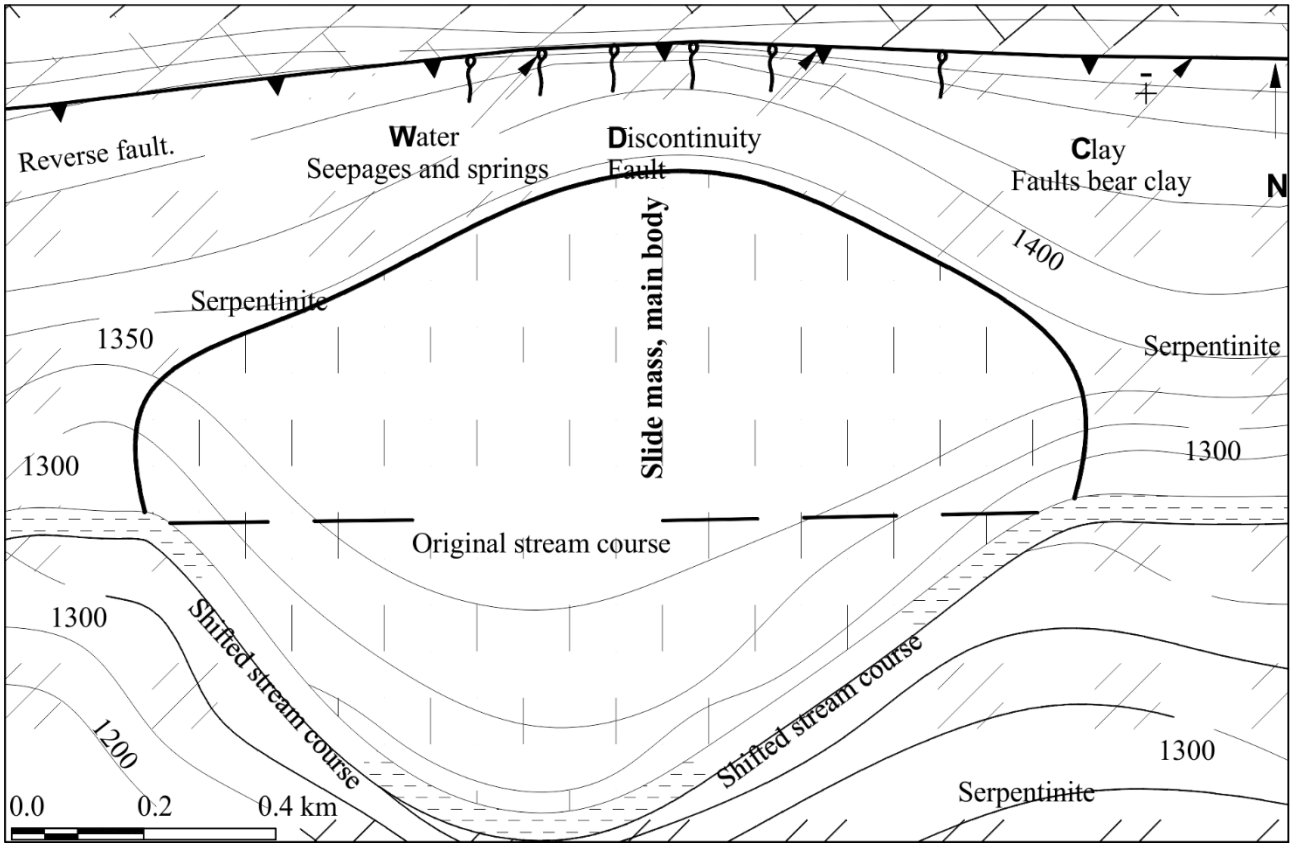

Figure 3. *Two Concave Contour Sets (Leventeli et al., 2019)*

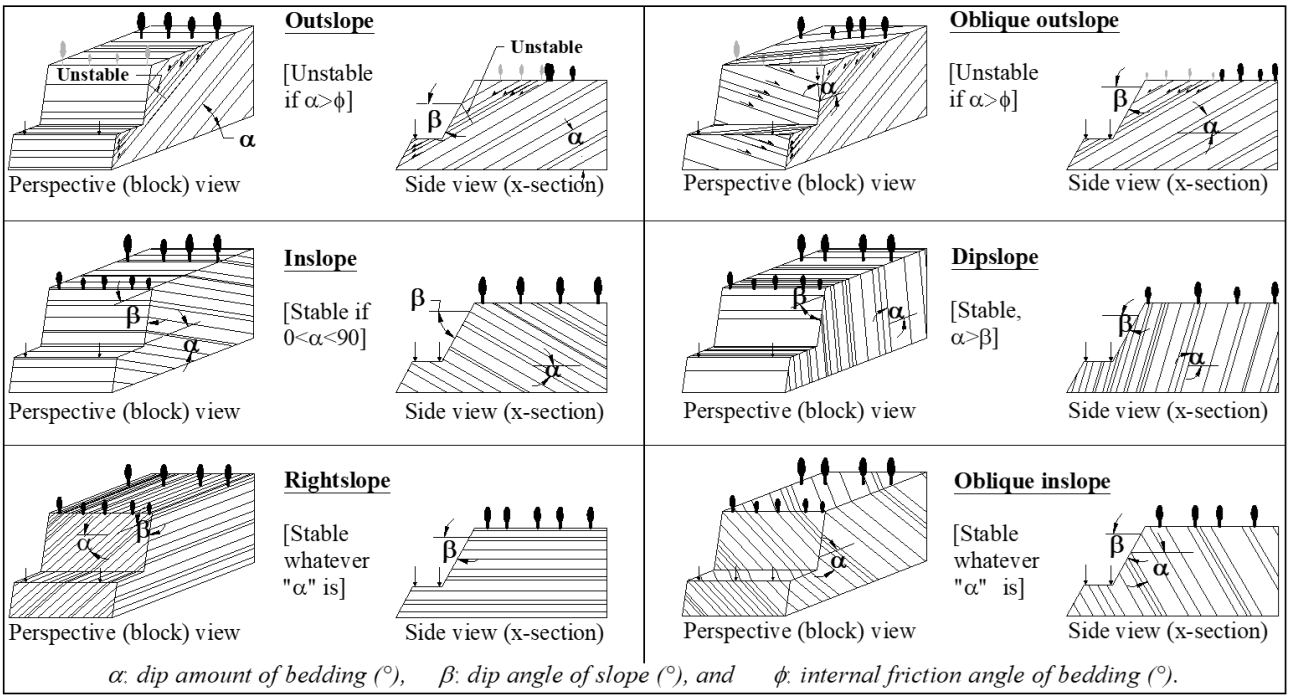

Figure 4. *The Relationship Between Discontinuities and Slopes (after Yilmazer et al.,1994;1997a; Yilmazer, 1995; Leventeli et al., 2019)*

2. MATERIAL AND METHOD

Some examples from international projects have been given below to understand the material and also methods.

2.1. Major Slide in Ankara-Istanbul Motorway

The Ankara – Istanbul motorway is an international project and 450 km in length between Ankara (40˚0'56.12"N-32˚37'36.48"E) and Istanbul (40˚59'48.45"N-29˚7'48.52"E) (Figure 5). In case of the proposed rules of "parenthesis ( )" and "asymmetrical valley slopes" (Figure 6) are accounted corridor and route selection study could be performed in a few days with high level of confidence (Yilmazer, 1995; Yilmazer et al., 1997b; 2004; Orhan & Yılmazer, 2006). According to Bell (2007), Marinos et al. (2005), Hoek et al. (1992) and Bieniawski (1989) geology is an art of the science. They have suggested very practical approaches to realize and describe the prevailing geological and geotechnical conditions. Experience together with the principles of geology and engineering is the main force behind engineering projects. It is impossible to carry and/or simulate the field conditions into laboratories.

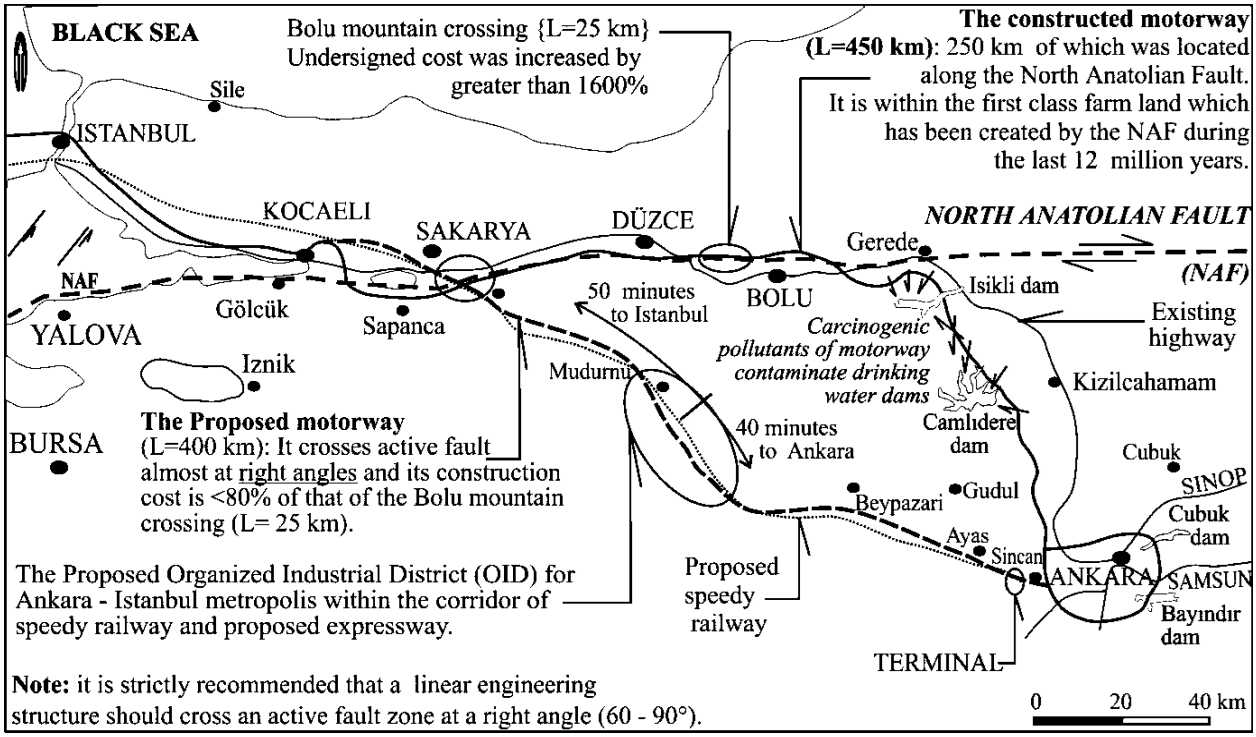

Figure 5. *The Location of the Ankara – Istanbul Motorway (Yılmazer, 2002; 2012; Leventeli et al., 2019)*

Although the landslide depicted in Figure 6 is quite obvious the alignment was located over the slide mass. Although the authors warned colleagues from different countries involved in this project they executed a heavy subsurface investigation program including drilling. Asymmetrical valley slopes are also very distinct on map. Hence one may easily and practically be able to recognize which slope is more stable or prone to slide (see Figures 4 – 6). This case study reminded the authors that (1) they started to examine chlorophyll without accounting forest and tree and (2) and commenced astronomic search from the bottom of a deep well. Some of the inevitable results are (a) the undersigned cost (67 million dollars) rose up to 1,642 million dollars which is a sky-high increase and in any case unacceptable and (b) the undersigned construction period (3 years) exceeded 16 years. From engineering stand point, it is unacceptable that their fault is paid by the country via changing items of the international agreement.

2.2. Road At Collision of Two Slides

A huge landslide with a volume of $75*10^6$ m^3 was crossed by a local road in 1950 (Figures 7 - 8). In 1992 a new road with very low standards was constructed. The authors designed a new one with high standards in 1998.

The new road was located over the stream course. Stream deposit is characterized by granular alluvium (Qa). Since the last glaciation (Todd, 2005) both slides were active. Every slide, from any side, has blocked out the valley. Then the fines and sand to fine gravels have been washed away. A rockfill with a height 5 to 12 meters

formed a highly pervious buttress resisting toes of both slides. Two lined "U" channels were located at both sides of the road. More than these, effective drainage system was implemented (Yilmazer et al., 2003). The proposed road was opened to traffic in 2005 and works efficiently. Both landslides are stabilized.

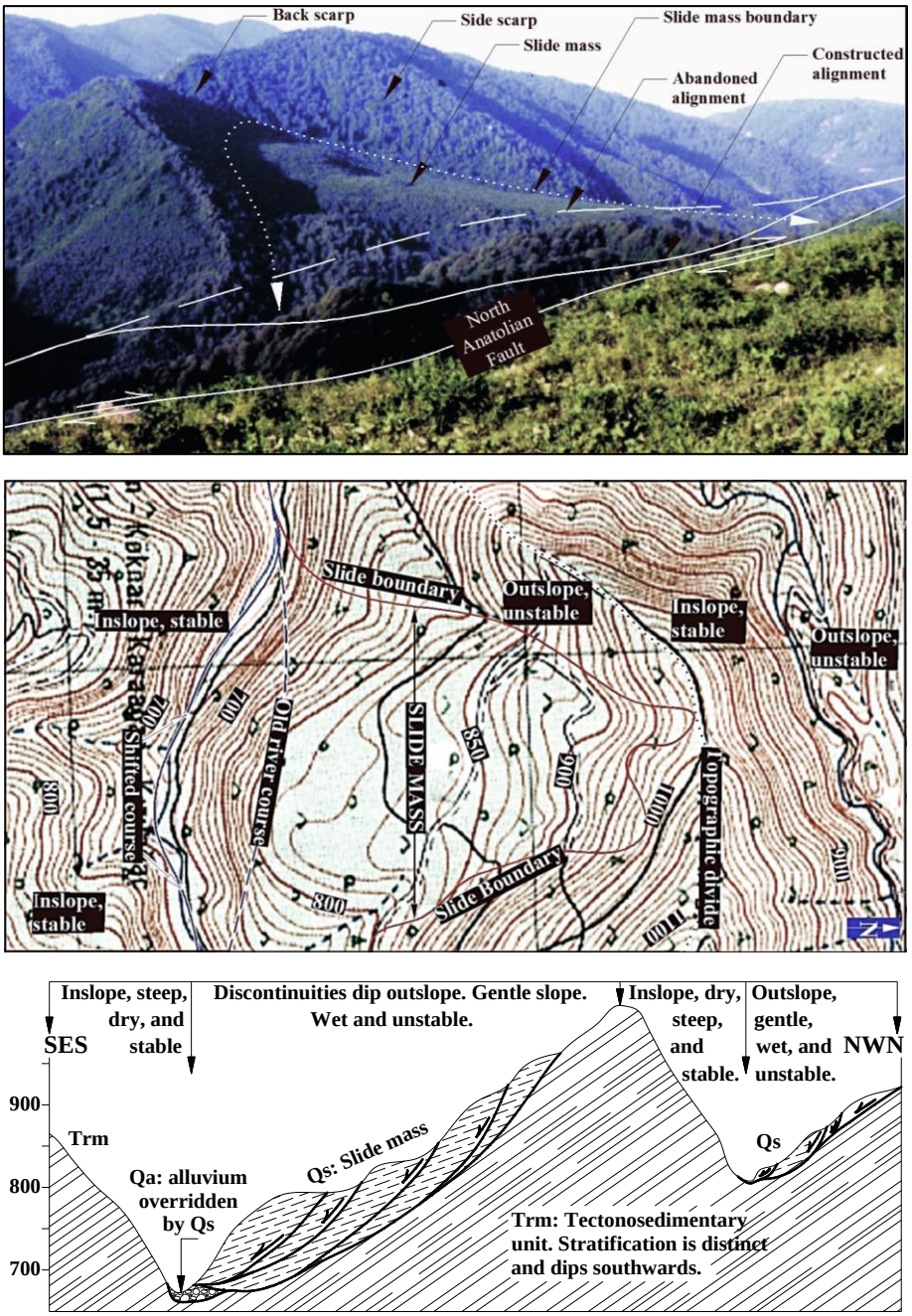

Figure 6. *Distinct Slide with Two Concave Contour Sets and Asymmetrical Valley Slope*

2.3. Slides Developed in Wisconsin Ice Age

As briefed above all geotechnical problems including landslides are affected by the trinity of water, discontinuity and clay (WDC). Groundwater has been recharged at high rate during the Last Glaciation, specifically Wisconsin Ice Age which is extended from 85,000 to 11,000 years ago, approximately. It was very effective in Anatolia in the period of B.C. 40,000 – 10,000 (Kurter, 1991). Majority of the naturally active landslides formed in the period of 10000 to 4000 BC. Two of them, which have a natural curiosity that is attracting visitors, are presented herein.

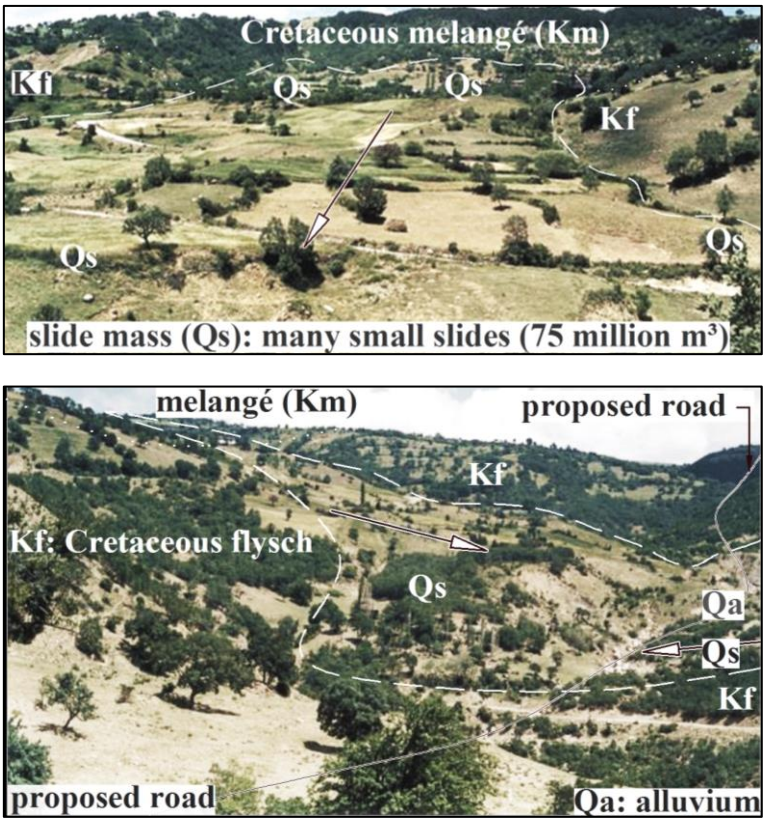

Figure 7. *Two Major Slides Moving to Each Other*

2.3.1. Noah's Ark (?) on Uzengilli Landslide

The Uzengili slide developed in Kretaceous colored mélange (ophiolite) denoted by Kmo. The unit includes numerous large scale submarine slides. As seen in Figure 9 an olistolith of tight fold within the unit Kmo seems a ship from far. On 29th of April 2010 it has been declared that "the Noah's Ark is found on Mount Ararat". A massive publication has been done to mislead the public. Unfortunately, there are some earth scientists among them supporting this rumor.

According to the mythology Noah's Ark (ship) landed on Mount Judi or Mount Ararat which are the abruptly rising mountains in the basin of Euphrates and Tigress Rivers. The announcement does not have any scientific base. Four of the main evidences are briefed below.

(1) According to mythology Noah's Ark landed on Mount Ararat or Mount Judi. The Elevations of Mount Ararat, Judi, and Uzengilli site are 4137, 2089, and 1970 m respectively.
(2) Ararat is a very young mountain. It dates back to 2450±50 BC according to the anthropologic evidences. The primary volcano type is stratovolcano (Q_{β}). Last explosion was in 1840. Hence it has not been affected from Wisconsin Ice Age. However, the Uzengilli formation formed over 60 million years ago as an ophiolitic mélange. It consists mainly of submarine slides, tectonic slabs, and olistostromes. Common rock types are serpentinite, pillow basalts, and radiolarite.
(3) The location of Uzengilli is not a part of Ararat. There is a wide basin (elevation: 1444 m) between Uzengilli site and Mount Ararat.
(4) Last but most importantly the unit Kmo has numerous landslides because of its low shear strength components such as serpentinites and soft binding materials of olistostromes. Slippery major discontinuities such as tectonic contacts and stratifications developed well. However the unit Q_{β} does not have discontinuity. Majority of the igneous contacts are amalgamated, rough, irregular and discontinuous. Since it is very young tectonic and structural contacts did not develop.

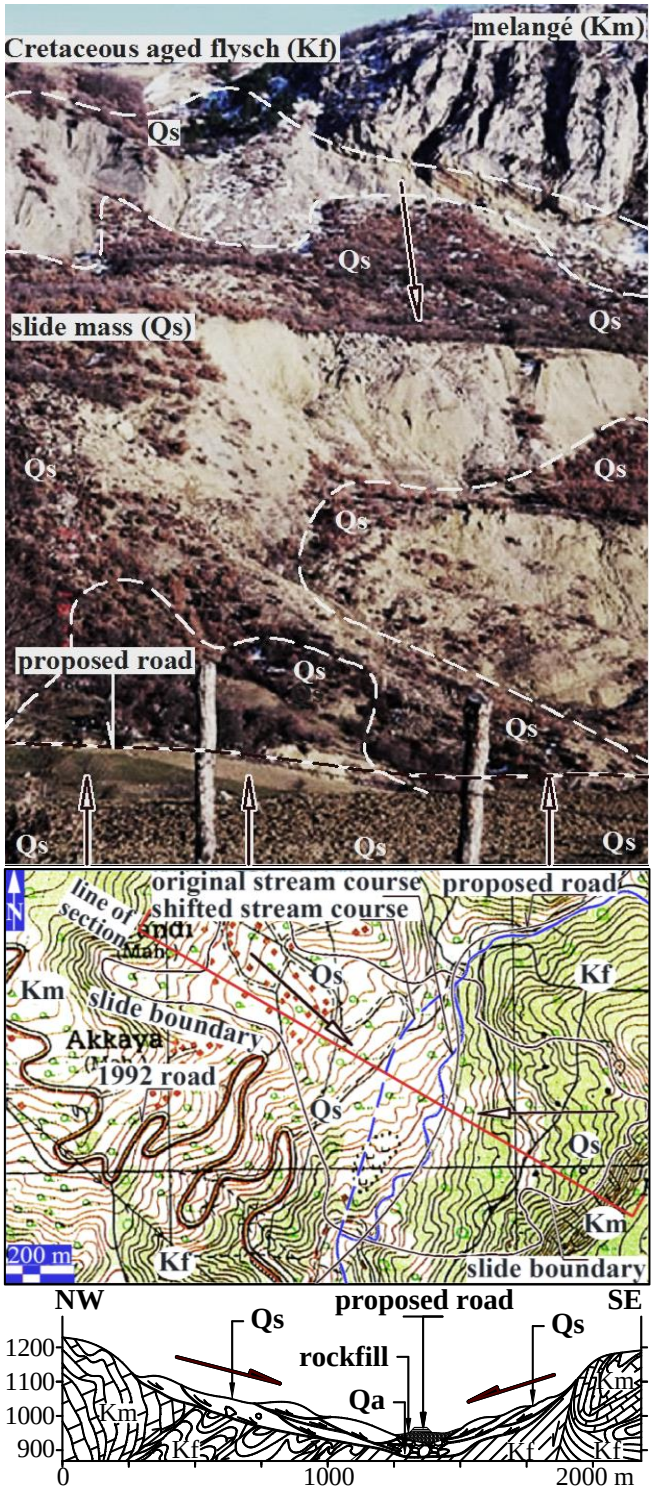

Figure 8. *A Highway is Located Between Two Major Slides Moving to Each Other*

Hence one may conclude that the declaration supposing *"the Noah's Ark first reached Ararat after the great flood and it is found on Mount Ararat in 2010"* misleads public. The authors and their team are authorized to investigate and design a motorway between Erzurum and Gurbulak gate at the border of Iran. The motorway passes adjacent to the Uzengilli site and far from Mount Ararat.

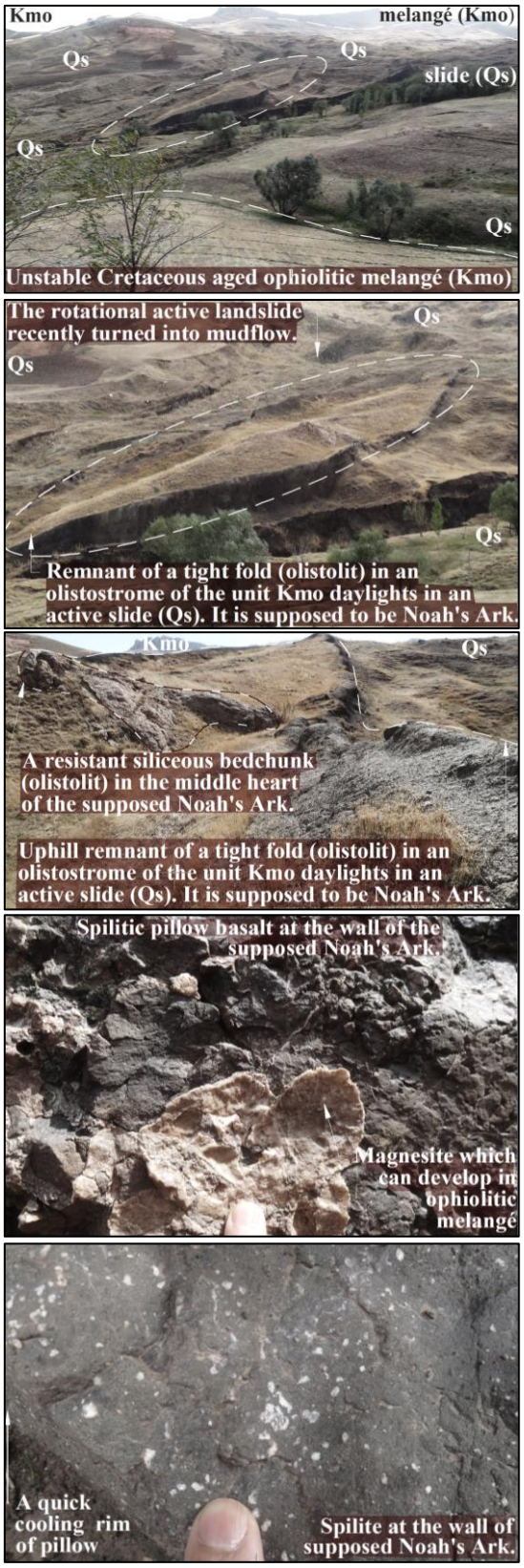

Figure 9. *The Supposed Noah's Ark Site and Relevant Geological and Engineering Geological Explanation*

2.3.2. Floating Islands in Hazersah Landslide

Floating islands formed in in the region of the city Bingol which denotes thousandlakes. It was during the melting period of ice cover, roughly 10,000 – 6,000 BC (Figure 10). Numerous slides developed in volcano-

sedimentary unit consisting mainly of tuff and agglomerate. A rotational slide having a small lake at top of the main slide body formed (see Figure 1). Water loving plants and vegetation such as cattails, bulrush, sedge, and reeds commence to grow along the shoreline and extend offshore (into lake). Storm events may tear some sections free from the shore. The separated islands can migrate on lake around with changing winds or manpower. Three islands in the middle of the lake have the ability to move freely on the lake. The islands are composed of vegetation growing on a buoyant mat of plant roots and other organic detritus. Thickness of the floating mat is measured as 0.5 to 1 m. The roots of plants could not reach bottom soil. However their roots use the oxygen in their root mass for buoyancy.

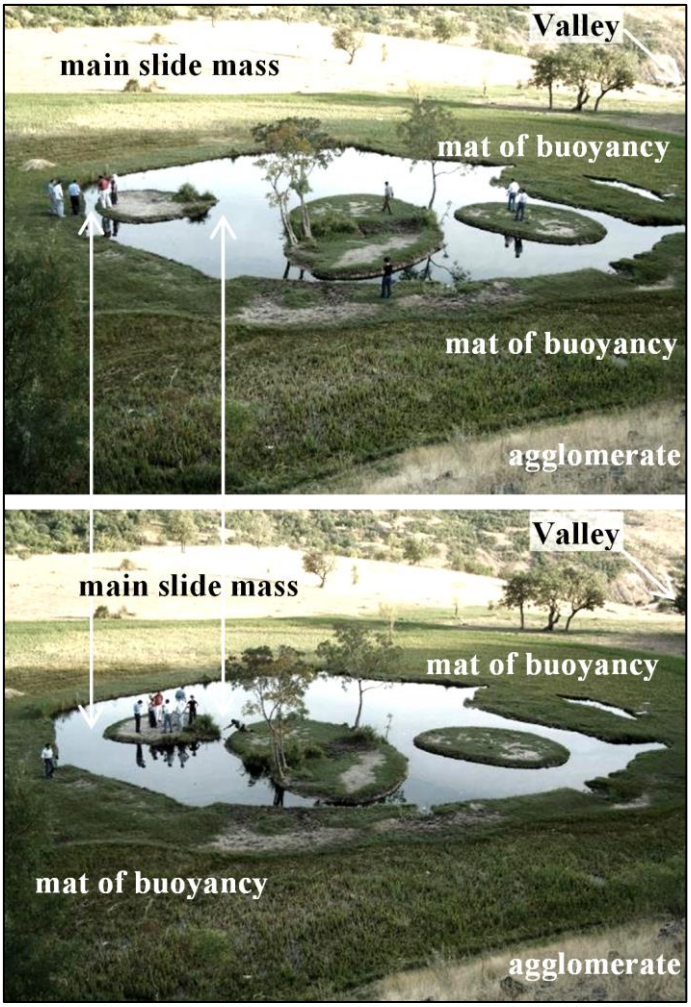

Figure 10. *Three Floating Islands Move Freely on the Lake of a Slide when a Force is Applied*

3. DISCUSSIONS AND CONCLUSIONS

The proposed "parenthesis ()" rule is important as a first step to determine the landslide boundary on the topographic map. The back scarp has steep slope with concave contours towards downstream and toe has steeper slope with concave contours toward upstream. The top of main slide body is flatter and might have a lake at top. Active slide boundaries along a route could be drawn in a few hours on relevant topographic maps. The same job could be performed more than a few months in the field.

The suggested rule of "*asymmetrical valley slopes*" is also quite helpful to envisage major discontinuity attitude. It is very important especially in linear structure projects such as road, railway, and pipeline in rugged terrains. Most of rocks include layering and bedding; and also the trinity water - discontinuity – clay (WDC) is the main cause of the geotechnical problems. So, the potential slide areas in stratified units could be mapped in a very short time on the topographic maps.

Upon following the forwarded two rules the volume of surface and subsurface investigation goes down about 90% in hummocky to highly dissected terrains. The distinction of rocky and soil grounds could also be performed via the suggested rules. At this point based upon the authors' over 40 year experiences, it is strongly recommended to use rocky grounds for settlement and soil grounds for farm activities. Over 99% of earthquake disasters occur in fertile soil grounds.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Bell, F. G. (2007). Engineering Geology. 2nd edition, Elsevier, Oxford.

Bieniawski, Z. T. (1989). Engineering rock mass classification: A complete manual for engineers and geologists in mining, civil and petroleum engineering. Wiley, NewYork.

Hoek, E., Wood, D., & Shah, S. (1992). A modified Hoek-Brown criterion for jointed rock masses. In: Rock Characterization, ISRM Symposium, Eurock'92, Chester, September 14-17, 209-213.

Kurter, A. (1991). Glaciers of the Middle East and Africa – Glaciers of Turkey. Satellite Image Atlas of Glaciers of the World, U.S. Geological Survey Professional Paper - 1386-G-1.

Leventeli, Y., Yilmazer, O., & Yilmazer, I. (2019). Discontinuity Nomenclature and Its Significance in Geotechnics. *Geotechnical and Geological Engineering*, *37*(6), 5349-5357.

Marinos, V., Marinos, P., & Hoek, E. (2005). The geological strength index: applications and limitations. *Bulletin of Engineering Geology and the Environment*, *64*, 55-65. doi:10.1007/s10064-004-0270-5

Orhan, A. H., & Yılmazer, I. (2006). Alignment selection criteria for pipelines essential. *Pipeline & Gas Journal*, *233*, 43-44.

Todd, D. K. M. (2005). Groundwater Hydrology. John Wiley & Sons Ltd, New York.

Yilmazer, I. (1995). Significance of discontinuity survey in motorway alignment selection. *Engineering Geology*, *40*, 41-48. doi:10.1016/0013-7952(95)00018-6

Yilmazer, I. (2002). A permanent solution to earthquake disaster. Kaynak Publication Co., Ankara (in Turkish).

Yilmazer, I. (2012). Earthquake secrete. Yılmazer Education and Engineering Ltd., Ankara (in Turkish).

Yilmazer, I., Selcuk, S., & Tumer, H. (1994). Cut slope recommendation. In: Proceedings of 7th Congress of the International Association of Engineering Geology Organization Committee, Lisbon, September 5-9, 3909-3919.

Yilmazer, I., Yilmazer, O., & Dogan, U. (1997a). Significance of water, discontinuity, and clay (WDC). In: Proceedings of the International Symposium on Engineering Geology and the Environment, Athens, June 23-27, 457-462.

Yilmazer, I., Leventeli, Y., & Akduman, L. (1997b). Recognition of distinct morphologies and its significance on site selection study. In: Proceedings of the International Symposium on Geology and Environment, Istanbul, September 1-5, 167-173.

Yilmazer, I., Yilmazer, O., & Sarac, C. (2003). Case history of controlling a major landslide at Karandu, Turkey. *Engineering Geology*, *70*, 47-53. doi:10.1016/S0013-7952(03)00081-4

Yilmazer, I., Yilmazer, O., Ozvan, A., & Bicek, C. (2004). Alignment selection criteria for pipelines and motorways. In: Proceedings of the 5th International Symposium on Eastern Mediterranean Geology, Thessaloniki, April 14-20, 1034-1037.